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DEC 29 1964

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## RESEARCH NOTE LS-51

LAKE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

### Vertical Distribution of Cones in Red Pine

A survey of cone-bearing red pines, *Pinus resinosa* Ait., in the Lake States indicates that cones in individual trees are concentrated in the middle third of the crown (fig. 1), and that vertical cone distribution is related to certain branch characteristics. This information is important to foresters, seed collectors, and entomologists concerned with the sampling, harvesting, and protection of cones.

Twenty-two trees bearing good cone crops were sampled from two areas in Wisconsin and three in Minnesota. Alternate whorls were removed from the crowns and the following data recorded: (1) whorl height on the stem; (2) branch azimuth; (3) branch length; (4) branch base diameter; and (5) total number of conelets and cones. In addition, the total number of male flower clusters was recorded for the 14 trees sampled in Minnesota. In the older and taller trees every third or fourth whorl was selected in order to reduce the number of branches sampled.

Correlation analyses indicated that branch characteristics were related to cone production. The correlation of cone production and branch size (length times base diameter) was significant. Higher correlation coefficients, however, resulted from the regression of cone production on branch size times branch height position; all  $r$  values were highly significant (table 1). Cone production correlated with branch size divided by branch age

resulted in lower but still highly significant  $r$  values.

Cone production is not related entirely to the measured physical branch factors, however. Maximum cone production per unit of branch size occurred farther up the crown than did maximum cone production per branch, thus indicating greater productivity in the younger branches. The male flowers, however, were concentrated in the bottom half of the crown (fig. 2).

The higher cone production in the younger branches and the concentration of male flowers in the older ones illustrate the relation between branch age and sexuality. Wareing<sup>1</sup> states that in Scotch pine young branches tend to be first vegetative or female. As they become older, they produce both female and male flowers and eventually tend to produce only male flowers. Both cone and male-flower production are also apparently less on the lower, less vigorous branches of older trees than on the lower branches of young trees. This relationship is reversed above midcrown (figs. 1 and 2).

All evidence indicates that the top of the crown is the main area of cone and seed production in

<sup>1</sup> Wareing, Philip F. Reproductive development in *Pinus sylvestris*, In *The Physiology of Forest Trees*, Kenneth V. Thimann, ed. Pp. 643-655. Ronald Press Co., New York. 1957.

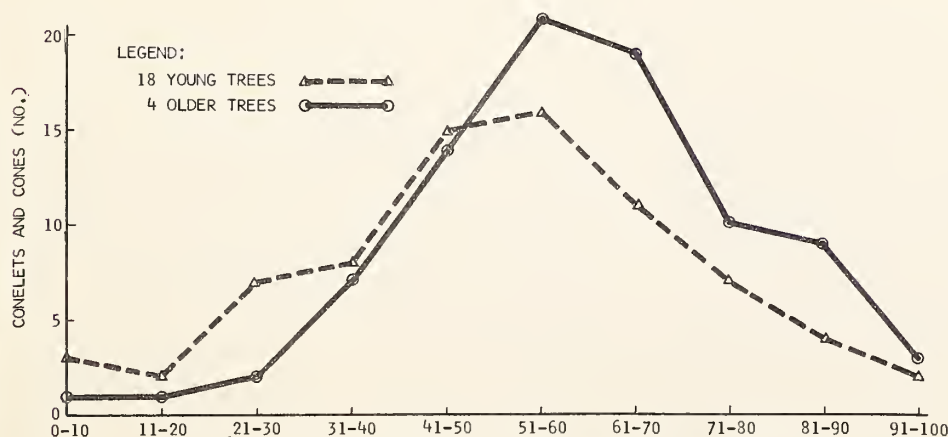


FIGURE 1. — Average number of conelets and cones per sample branch by crown tenths (6,179 conelets and cones).

TABLE 1. — Correlation coefficients of cone production vs. branch characteristics (averages) in 22 red pine trees in Wisconsin and Minnesota

Area and year sampled	Stand condition	Trees	D.b.h.	Height	Age	Effective crown <sup>1</sup>	<sup>2</sup> r
		Number	Inches	Feet	Year	Percent	
Three Lakes, Wis., 1962	Open, planted	5	12	28	25	100	+0.82
Lakewood, Wis., 1962	Open, natural	3	12	35	35	88	+0.69
Echo Trail, Superior NF, 1963	Partially closed, planted	4	11	36	35	90	+0.72
Seed-production area, Isabella, Minn., 1963	Closed, natural stand	4	14	66	69	49	+0.81
Inga Lake, Isabella, Minn., 1963	Open, natural stand, jack pine understory	6	9	36	59	73	+0.86

<sup>1</sup> Does not include lower stagnating and dying branches.

<sup>2</sup> The correlation coefficient of conelets and cones per branch vs. the product of branch length (feet)  $\times$  branch base diameter (inches)  $\times$  branch height position in the crown (percent). All individual  $r$  values are significant at the 5-percent level, 21 are significant at the 1-percent level.

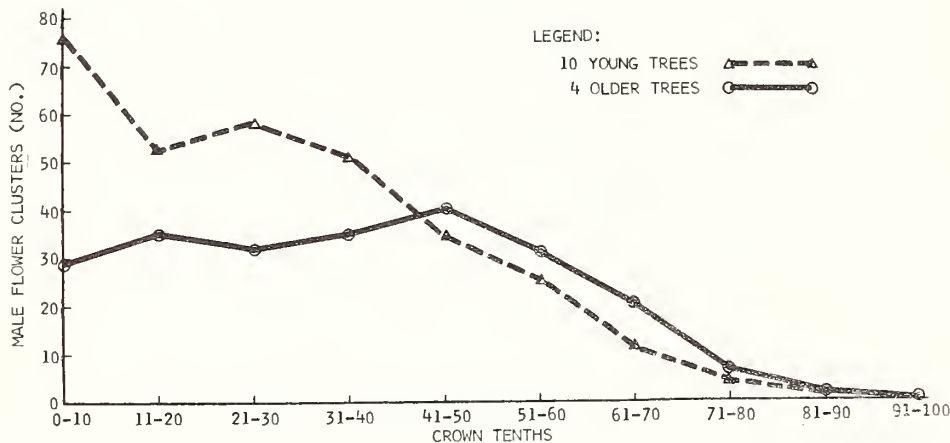


FIGURE 2. — Average number of male flower clusters per sample branch by crown tenths (11,657 male flower clusters).

the older trees. Lyons<sup>2</sup> has stated that the largest and most productive cones in red pine are found in the upper portion of the tree crown. Furthermore, the outer, most productive portions of the branches are higher than their points of attachment to the stem because of branch curvature.

<sup>2</sup> Lyons, L. A. The seed-production capacity and efficiency of red pine cones (*Pinus resinosa* Ait.). *Canad. Jour. Bot.* 34: 27-36. 1956.

The vertical distribution of cones has economic significance, especially in older stands. Climbers are prevented from going above a 4-inch top for reasons of safety; thus harvest of the most desirable cones is a problem. Furthermore, if effective chemical control is to be realized in older trees, mist blowers or sprayers must be powerful enough to reach the high cone-producing areas of the crown.



